

CLAIMS:

We claim:

1. A device comprising:

a first semiconductor light emitting device comprising a stack of semiconductor layers including an active region; and

an optical element bonded to the first semiconductor light emitting device;

wherein the optical element is elongated in a first direction.

2. The device of claim 1 wherein the first semiconductor light emitting device is elongated in the first direction.

3. The device of claim 1 further comprising a second semiconductor light emitting device comprising a stack of layers including an active region bonded to the optical element next to the first semiconductor light emitting device.

4. The device of claim 3 wherein the active region of the first semiconductor light emitting device and the active region of the second semiconductor light emitting device emit light of different colors.

5. The device of claim 1 wherein the optical element is bonded to the first semiconductor light emitting device by a bond at an interface disposed between said optical element and said first semiconductor light emitting device, wherein said bond is substantially free of organic-based adhesives.

6. The device of claim 1 wherein the optical element is an optical concentrator.

7. The device of claim 1 wherein:

the optical element has a first surface adjacent to the bond connecting the optical element to the first semiconductor light emitting device, a second surface substantially parallel to the first surface, and a substantially parabolic cross section; and

an area of the first surface is smaller than an area of the second surface.

8. The device of claim 7 wherein the optical element has a side surface.

9. The device of claim 8 wherein the side surface connects the first surface to the second surface.

10. The device of claim 8 further comprising a mirror on at least a portion of the side surface.

11. The device of claim 1 further comprising a light guide adjacent to the optical element.

12. The device of claim 11 wherein the light guide is in contact with the optical element.

13. The device of claim 11 wherein the light guide is spaced apart from the optical element.

14. A device comprising:

a semiconductor light emitting device comprising a stack of semiconductor layers including an active region; and

an optical element bonded to the semiconductor light emitting device;

wherein the semiconductor light emitting device and the optical element are positioned in a reflector.

15. The device of claim 14 further comprising a heat sink attached to the semiconductor light emitting device.

16. The device of claim 14 wherein the optical element is shaped to direct a portion of light emitted by the active region in a direction substantially perpendicular to a central axis of the semiconductor light emitting device and the optical element.

17. The device of claim 16 wherein the reflector is shaped to direct a portion of the light exiting the optical element in a direction substantially parallel to the central axis.

18. The device of claim 14 wherein the optical element is bonded to the semiconductor light emitting device by a bond at an interface disposed between said optical element and said semiconductor light emitting device, wherein said bond is substantially free of organic-based adhesives.

19. The device of claim 14 further comprising a light guide adjacent to the reflector.

20. The device of claim 19 wherein the light guide is in contact with the reflector.

21. The device of claim 19 wherein the light guide is spaced apart from the reflector.

22. A device comprising:

a first semiconductor light emitting device comprising a stack of semiconductor layers including an active region; and

an optical element bonded to the semiconductor light emitting device;

wherein the optical element is shaped to direct a portion of light emitted by the active region in a direction substantially perpendicular to a central axis of the semiconductor light emitting device and the optical element.

23. The device of claim 22 wherein the optical element comprises a wedge comprising:

a first surface adjacent to the bond connecting the optical element to the first semiconductor light emitting device;

a substantially flat second surface substantially perpendicular to the first surface;
and

a substantially flat third surface connecting the first and second surfaces.

24. The device of claim 23 further comprising a mirror adjacent to at least a portion of the third surface.

25. The device of claim 22 wherein the optical element comprises:
- a first surface adjacent to the bond connecting the optical element to the first semiconductor light emitting device;
- a substantially flat second surface substantially perpendicular to the first surface;
- and
- a curved third surface.
26. The device of claim 25 further comprising a mirror adjacent to at least a portion of the third surface.
27. The device of claim 25 wherein the curved third surface connects the first and second surface.
28. The device of claim 25 wherein the curved third surface curves downward from the second surface toward a point on a central axis of the optical element and semiconductor light emitting device.
29. The device of claim 22 wherein a cross section of the optical element is thinner in a central region than in a peripheral region.
30. The device of claim 22 wherein a surface of the optical element comprises a reflector.
31. The device of claim 30 wherein the reflector is selected from the group of a metallization, a dielectric layer, a reflective coating, and a total internal reflector.
32. The device of claim 22 wherein the optical element is bonded to the semiconductor light emitting device by a bond at an interface disposed between said optical element and said semiconductor light emitting device, wherein said bond is substantially free of organic-based adhesives.
33. The device of claim 22 wherein the optical element is elongated.
34. The device of claim 33 wherein the optical element comprises a rectangular slab.

35. A device comprising:

- a first semiconductor light emitting device comprising a stack of semiconductor layers including an active region;
- an optical element bonded to the semiconductor light emitting device; and
- a light guide adjacent to the optical element.

36. The device of claim 35 wherein the light guide is in contact with the optical element.

37. The device of claim 35 wherein the light guide does not touch the optical element.

38. The device of claim 35 wherein the light guide comprises:

- a first surface adjacent to the optical element; and
- a second angled surface, wherein and angle between the first and second is greater than 90 degrees.

39. A device comprising:

- a semiconductor light emitting device comprising a stack of semiconductor layers including an active region; and
- an optical element bonded to the first semiconductor light emitting device;
- wherein the optical element comprises a material selected from the group of an oxide of tellurium, aluminum oxynitride, cubic zirconia, transparent alumina, and spinel.

40. The device of claim 39 wherein the optical element is bonded to the semiconductor light emitting device by a bond at an interface disposed between said optical element and said semiconductor light emitting device, wherein said bond is substantially free of organic-based adhesives.

41. A device comprising:

a semiconductor light emitting device comprising a stack of semiconductor layers including an active region;

an optical element bonded to the semiconductor light emitting device; and

a bonding layer disposed between the optical element and the semiconductor light emitting device;

wherein the bonding layer comprises an oxide of tellurium.

42. The device of claim 41 wherein the semiconductor light emitting device comprises one of a substrate and a superstrate.

43. The device of claim 42 wherein the one of a substrate and a superstrate comprises a material selected from the group of sapphire, SiC, aluminum oxynitride, zirconia oxide, GaN, AlN, spinel, GaP, ZnS, an oxide of tellurium, an oxide of lead, an oxide of tungsten, and transparent alumina.

44. The device of claim 41 further comprising a plurality of grooves formed on the optical element.

45. The device of claim 41 wherein the optical element comprises a Fresnel lens.

46. The device of claim 41 further comprising a Fresnel lens formed on the optical element.

47. The device of claim 41 further comprising a reflective material formed on at least a portion of the optical element.

48. The device of claim 41 wherein the bonding layer has a softening temperature between about 250 °C and about 500 °C.

49. The device of claim 41 wherein the shape of the optical element is one of a dome, a paraboloid, a cone-shape, and a beveled shape.

50. The device of claim 41 wherein the optical element comprises one or more luminescent materials, capable of converting a wavelength of light emitted by the stack of layers to at least another wavelength.

51. The device of claim 41 wherein a portion of the optical element is coated with one or more luminescent materials, capable of converting a wavelength of light emitted by the stack of layers to at least another wavelength.

52. The device of claim 41 wherein the bonding layer comprises one or more luminescent materials, capable of converting a wavelength of light emitted by the stack of layers to at least another wavelength.

53. The device of claim 41 wherein at least one surface of the stack of layers is beveled.

54. The device of claim 41 wherein a bottom surface of the optical element is substantially parallel to a growth direction of the stack of layers.

55. The device of claim 41 wherein a bottom surface of the optical element is substantially perpendicular to a growth direction of the stack of layers.

56. The device of claim 41 wherein the semiconductor light emitting device is bonded to the optical element in a flip chip orientation.

57. The device of claim 41 wherein the optical element comprises a material selected from the group of sapphire, SiC, aluminum oxynitride, zirconia oxide, GaN, AlN, spinel, GaP, ZnS, an oxide of tellurium, an oxide of lead, an oxide of tungsten, and transparent alumina.